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Trail accessibility as a tool for sustainable management of protected areas: Case study Ceahlău National Park, Romania

Mioara Clius*, Alexandra Teleucă, Ovidiu David, Adrian Moroşanu

Department of Environment and Regional Geography, Faculty of Geography, University of Bucharest, Romania

Abstract

Accessibility is an indicator that involves two components: the place - with its morphological and morphometric features -, and man - who wants to reach that place. The relief accessibility map is a useful tool both for tourists and national park managers. Sustainable management in a park and planning involves the opening of new hiking trails which must take into account the relief accessibility, internal zoning, land use and the presence of tourist interest objectives. In this study we produced a map of relief accessibility for Ceahlău National Park (CNP) in Romania using two indicators: the slope and the land use. The model integrates both primary data and secondary data resulted from the reclassification operations. From the intersection of these secondary data in a transition matrix we have established five types of accessibility levels that are represented for the entire park and trails in the CNP. Of the total area of the park - which is located in Romania's eastern Carpathians, within a mountain unit with less than 1900 m altitude -, over 90% encompasses high and medium accessibility levels (types 2 and 3) which shows a high potential for planning. Data resulted from this model can be used for an efficient management of trails in a national park and their evaluation according to the degree of accessibility.

Keywords: trail accessibility; reclassification; hiking trails; sustainable planning; protected areas.

1. Introduction

Accessibility is an attribute of the place (e.g., accessible place) or the individual (e.g., personal accessibility) [1]. It is considered an essential factor in many aspects of the everyday life such as providing timely medical services [2, 3], the organization of streets networks in urban areas [4] or

* Corresponding author. Tel./Fax: +400213153074
E-mail address: mioara.clius@g.unibuc.ro

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protected areas management [5]. The most frequently used elements to describe access are those that relate to infrastructure quality (paved, forestry, path, etc.) ant the means of access (car, horse, pedestrian access, etc.). An important role in defining the access is attributed to specialists who design and manage the infrastructure, which set standards for access systems. They can use this combination of natural aspects, design, maintenance and usage rules in order to facilitate or restrict access [6].

Defining accessibility varies according to the scope and purpose of analysis. Moseley [7] considers that a place is not only more or less accessible, but its accessibility is related to people and the experiences they require. He emphasizes the role played by accessibility in a geographical context, social and economic also. U.S. Department of the Environment [8] defines accessibility as the facility and convenience to achieve various spatial objectives. It varies depending on the type of travel or conducted activities [9, 10]. Accessibility can be understood as an opportunity for urban inhabitants to quickly benefit from certain locations or institutions [10, 11], and in protected areas as an opportunity for recreation, in which case it may be the result of a combination of physical conditions, biological, social and management features that assign value to a place [6]. Accessibility is most often measured through the distance between two points (i.e., distance to a point of interest), the time required for its transition [12] or the capacity to benefit of certain services [13].

Modeling space accessibility using GIS techniques [14] or even developing a planning support system for sustainable tourism infrastructure are constant concerns lately. Boers and Sottrell [15] have developed a model of sustainable tourism infrastructure planning for protected areas that integrate the tourism elements and the geo-information science. Based on this model, a path should contribute to the development objectives of the protected area, but also to support tourists in reaching their own visit objectives. The objective of accessibility modelling is not to estimate the distribution of visitors but rather to estimate how much space is accessible from any location of the park [6].

The link between sustainable planning and accessibility is very strong in protected areas. Bayarsaikhan et al. [16] emphasizes the role that management and design standards have for the establishment of access categories in certain areas, and that because tourism in protected areas within mountainous regions should benefit from a sustainable infrastructure in terms of economical and environmental demands [17, 18, 19]. To reduce the negative consequences on the protected area sustainability should impose even a development direction of the accessibility policy in view of its social, economic and environmental implications [20, 21].

National parks managers should properly manage the existing recreational resources. This involves changing some trails - in accordance with the tourist demand or in regard to the protection objectives -, the rehabilitation of others or of the existing facilities [22]. They must implement the legislative regulations that intend to ensure a proper recreational management by reducing impacts and guaranteeing sustainable activities [23]. One of the most viable methods is to provide visitors with useful information in harmonization with the resource protection [24]. The national parks are not only part of preserving the habitats or species but they are also destined to provide accurate services to visitors [25], to enable equal access to all objectives of interest for tourists [26].

Accessibility has a decisive role in choosing a potential destination by the tourist. If he has several opportunities - the attractions offered by various destinations - often he will choose the highest accessibility offer [27].

Information regarding infrastructure of the trails in a national park is not only useful for tourists who plan their visits for achieving their objectives, but also for managers who can monitor and evaluate the trail quality in order to achieve the management objectives [28]. In national parks one of the threats on biodiversity consists in the excessive recreational use or insufficiently planned due to a poor management [13]. Even in a case of a fair and honest management, national parks are faced with problems that can arise due to external factors such as under-funding the administration or lacking of qualified personnel [29, 30]. Currently Romania has no coherent and sustainable plans of visiting any protected area.

In this study, we proposed testing a methodology for achieving the relief accessibility map as a useful tool both for tourists and the managers of protected areas. We started from the assumption that the relief's accessibility is a synthetic indicator that expresses the relief's potential for space planning and organization [31] and we will try to emphasize the pragmatic valence of such maps.

The model for the map of relief accessibility that we propose should help park managers to achieve goals such as developing new trails depending on the relief accessibility and on land use; planning trail segments for non-invasive tourist activities and with low tourist-impact (cycling, horse riding and climbing) and not least to create a tool for informing tourists about the accessibility of hiking trails.

2. Study area

The study site is represented by Ceahlău National Park (CNP), located within Ceahlău Massif, in the eastern group of Romanian Carpathians (Fig. 1). It was established as a national park (a protected area managed mainly for ecosystem protection and recreation – I.U.C.N, IInd category), in 2004 by Government Decision 230/2003, although it previously had the status of natural protected area since 1955 according to the Decision of Ministers Council no. 1625/1995. CNP has an area of 7 742.5 hectares and is the only national park in Romania which is managed by local authorities – Neamț County Council. Under the management plan developed in 2003 the floristic diversity (over 111 species) and fauna (over 200 species of vertebrates and 1100 species of invertebrates) determined the designation of this park as a site of community importance and has been integrated in the European ecological network Natura 2000.

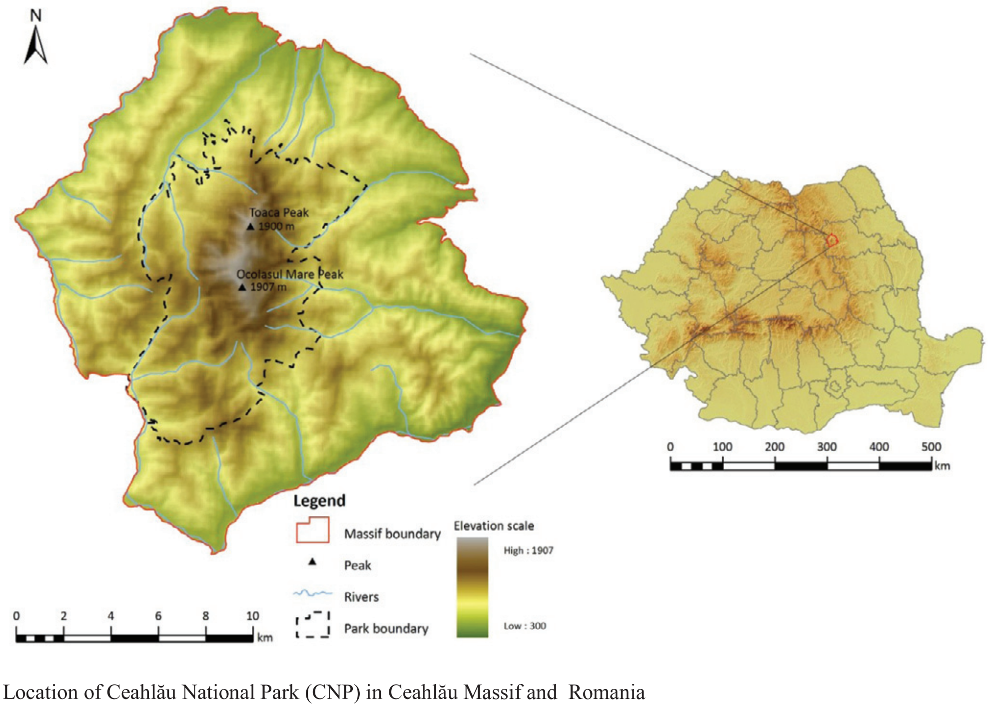


Fig. 1. Location of Ceahlău National Park (CNP) in Ceahlău Massif and Romania

In terms of morpholithology and morphostructure, CNP unfolds on the Cretaceous flysch unit which is composed in this case of Ceahlău conglomerates represented by a suspended syncline structure that gives it the appearance of a isolated mountain massif that is surrounded by cliffs [32]. The upper part of Ceahlău Massif presents heights of ~ 1900 m (Toaca Peak - 1900 m and Ocolașul Mare Peak - 1907m), which are positioned at the northern and southern extremities of a structural plateau. Its edges are represented by cliffs with slopes exceeding 65° (Ocolașul Mare Cliff, Ocolașul Mic Cliff, Stanilelor Cliff).

The tourism potential of the park on which most on hiking trails unfold is also represented by relief microforms that are characteristic to conglomerates (towers, limestone klippes), complemented by avens, erratic blocks, and waterfalls [32]. The annual number of visitors has a positive dynamic in recent years. Thus in 2006, 19818 tourists entered the CNP, in 2007 - 27 979, and in 2008 - 32 604 people visited the park (http://www.ceahlaupark.ro/, accessed 10.12.2010). Over 20% of them enter and camp in the park at the beginning of early August when the Mountain Day is celebrated [33].

The park has a network of roads with a convergent configuration from the mountain basis towards the central point of the mountain plateau (Dochia Chalet - 1849 m). These have a starting point in the rural communities that are located at the mountain basis and sum up 69 km [34]. Current routes overlap on access roads inside the mountain that are dating back to the XVIIth century. This is confirmed by Otzellowitz map of the year 1790 on which are represented the paths frequented by shepherds and monks during that period. These trails have been maintained with the financial support of the nobility from the area who has contributed to building the first shelters and later of the two houses in Ceahlău Massif, respectively Fântanele Chalet in 1854 and Dochia Chalet in 1907 [35].

3. Methods

For producing the relief accessibility map there were used two types of primary and secondary data. The primary data consisted of tracks recorded in two expeditionary travels (May and August 2010) using the GPS (Magellan eXplorist GC) for existing trails within the park, 1:25.000 scale topographic maps, orthophotoplans and Corine Land Cover 2006 (CLC) data that was downloaded from the EEA site [36].

The method we created is based on: collecting the field data (tracks of hiking trails); vectoring and rastering the cartographic materials; correction of information with the field reality; reclassification of the slopes and land use for creating the relief accessibility map for the entire park and for the existing trails. For data processing we used a suite of ArcGIS Desktop 9.3 software applications with which we vectored, stored, updated, processed and displayed the geographic data (Fig. 2).

The map we selected has the scale 1:25 000, this choice being based on the assumption of Hawes et al. [37] which states that scale measurements (scalar measurements) are preferable to the categorical ones (categorical measurement) since the last ones provide less information and are prone to errors. The type of representation chosen by us is consistent with the idea of Kwan et al. [1] who states that place accessibility assessment with GIS and other spatial data is best suitable because entities and the geographic space are structured in an analytical framework of a particular study.

Raster data for declivity and land use have been reclassified in order to obtain the secondary data. These were grouped into five categories: from the most accessible perimeters (code 1) to the most difficult accessible ones (code 5). Declivity reclassification was created in view of the 5 categories of slopes characteristic to the mountain space (Fig. 3). The lowest slopes (0-15°) were considered to have the highest accessibility (1) and the 60° - 90° slopes that are characterizing the cliffs from the structural plateau`s edge were considered very difficult to reach (5).

Based on expert opinion, land use was reclassified [10] depending on the type of vegetation but also the degrees of accessibility and visibility that a certain type allowed for tourists who pass through it (Fig 4).

Fig. 2. Steps followed during the creation of the relief accessibility map

The highest degree of accessibility (1) we considered to be the represented by anthropic areas such as villages located at the periphery of CNP (112 CLC code), pastures (231 CLC code), cultivated land (242 CLC code), natural pastures (321 CLC code) and areas with scattered vegetation (333 CLC code). Although forests are considered to be extremely attractive for tourists who cross them, we considered that these types of land use (311, 312 and 313 CLC code) impose limitations on accessibility through the slightly smaller visibility (2). The average accessibility (3) has been granted to the transitional ecoton which is represented by forests and shrubs (324 CLC code) considering that it is more difficult to transit or requires cutting for maintain the trails. In CNP the subalpine level (322 CLC code) is represented by large areas with *Pinus mugo* and *Juniperus communis* within the structural plateau and the upper part of the cliffs. They have a low accessibility (4) as their opening and maintaining the trails inside them is difficult. Very low accessibility (5) was given to the area occupied by cliffs (332 CLC code) that are generally avoided even by hiking trails.

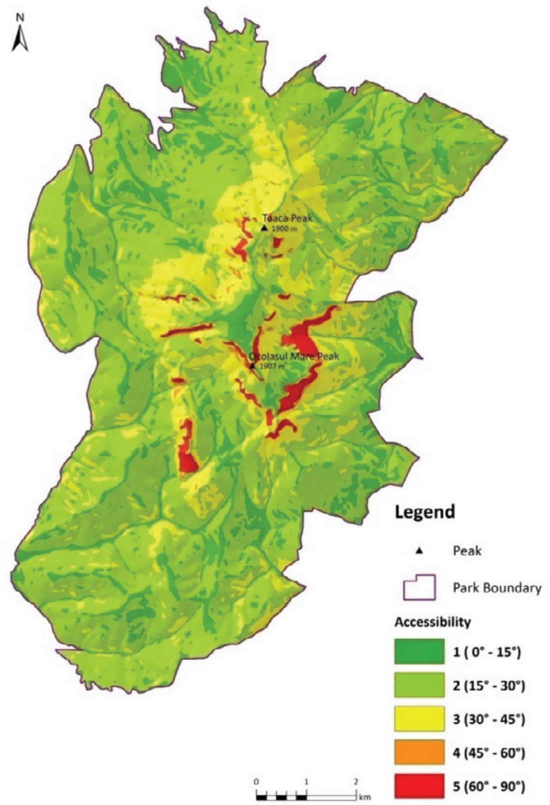


Fig. 3. The reclassified map of terrain declivity in CNP

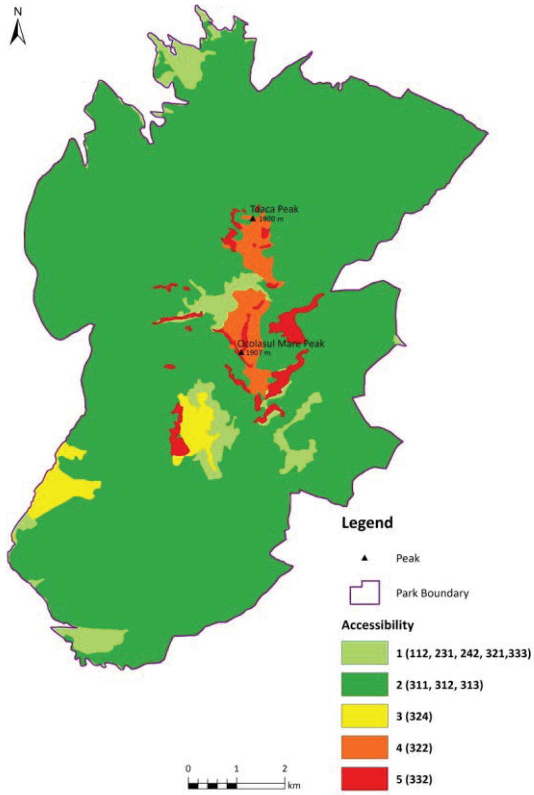


Fig. 4. The reclassified map of land use in CNP

In order to combine the accessibility resulting from the two reclassified maps we used a transition matrix inside which we intersected the reclassifications created for declivity and land use. It resulted in 25 types of combinations between the two parameters (Table 1).

Reclassification - at this stage - took into account the realities on the field. In addition we considered the hypothesis of Pelorosso et al. [38] who says that it is necessary to equalize the thematic content and spatial detail in order to increase comparability between heterogeneous maps.

We observed that the trails that have low slopes and cross areas occupied by meadows, pastures, cultivated land have the highest degree of accessibility (type 1). Trail segments with low and moderate slopes, but occupied by forests, meadows and pastures were assessed with high accessibility (type 2). In the case of medium accessibility (type 3) resulted seven categories of combinations.

Table 1. The transition matrix for determining the relief accessibility types (for slope and CLC codes see fig. 3and fig.4)

Slope reclassification code	CLC 2006 reclassification code	Accessibility code	Accessibility types
1	1	1	Very high
2	1		
1	2	2	High
2	2		
3	1		
1	3		
3	2	3	Medium
4	2		
2	4		
1	4		
4	1		
2	3		
3	3		
3	4	4	Low
4	3		
5	2	5	Inaccessible
5	5		
1	5		
2	5		
3	5		
5	4		
4	5		
4	4		
5	1		
5	3		

In some cases we found that large slopes are not insurmountable in combination with pastures (class 4 and CLC slope reclassification code 1). In other cases, although the slopes are reduced (declivity class 1) the trails cross the sub-mountainous level (CLC reclassification code 4) which is difficult to transit. We also appreciated as average accessibility all the segments with medium and high slopes (declivity classes 3 and 4) but which are crossing the forest ecosystems (CLC reclassification code 2). We considered that accessibility is reduced (type 4) for two types of combinations: where trails include high slopes (declivity class 3) and cross the subalpine level (CLC reclassification code 4) and very high slopes (declivity class 4) passing through the transition ecoton (CLC reclassification code 3). The sectors that were appreciated by us as inaccessible (type 5) are the most numerous (10 combinations) and can be delineated on the field due either to the high slopes or because of a certain land use. Where slopes are high (declivity class 4) and very high (declivity class 5), we considered the trail segments as inaccessible whether it comes to smaller values of accessibility for the land use (CLC reclassification code 1, 2, 3). The situation is also true in reverse, where there are rocky areas (CLC reclassification code 5) within the CLC, regardless of the slope, the usual tourist trail can`t be designed, the only situation in which these segments can be used is that for setting certain climbing trails.

4. Results

The map of relief accessibility (Fig. 5) reflects the massif type structure in which the center is a structural plateau surrounded by cliffs. 73.15% of the total park area has high accessibility (type 2) and mostly overlaps the slopes that are located at altitudes lower than 1,200 m being covered with deciduous and coniferous forests. The average accessibility (type 3) exists on 19.22% of the park surface and it is present in the upper part of the slopes at altitudes between 1200 and 1700 m. The highest accessibility degree (type 1) occupies small areas (4.75%) either on the structural plateau of the central part of CNP, or in two small depression basins in north and south. Poor accessibility (type 4 - 0.89%) and very low (type 5 - 1.99%) occur in the central part of the park and overlap the structural slopes at the Ceahlău Plateau`s boundaries. Part of the CNP`s hiking trails overlap and we have chosen this case to consider only trail segments in order to avoid duplication in the analysis.

All the trails represent in more than 50% the second type (high) and third one (average) of accessibility, and trail no. 2 is entirely within these parameters (Fig. 6). The reason for which all trails have medium and high accessibility is associated to the fact that they were folded on the historic roads that were used by locals. Routes 1, 4 and 6 have low accessibility (4) on reduced segments respectively: 1% for trail 6, for trail 1 it is 5% and 7% for trail 4, and this fact is because they climb on the eastern and northern cliffs of the massif. There are only two routes (3 and 4) with very small sections (6 m or 47 m long) with very low accessibility (type 5) at the crossing of glacial horns.

Using the percentages trend with varying degrees of accessibility for each track we create for CNP a triangular ramp (Fig. 7) that expresses the degree of difficulty for the trails in which the largest basis is represented by the easiest trail and the tip suggests the least accessible trail. So if the park administration decides to open a new tourist trail it can be compared, in terms of accessibility, to the current situation

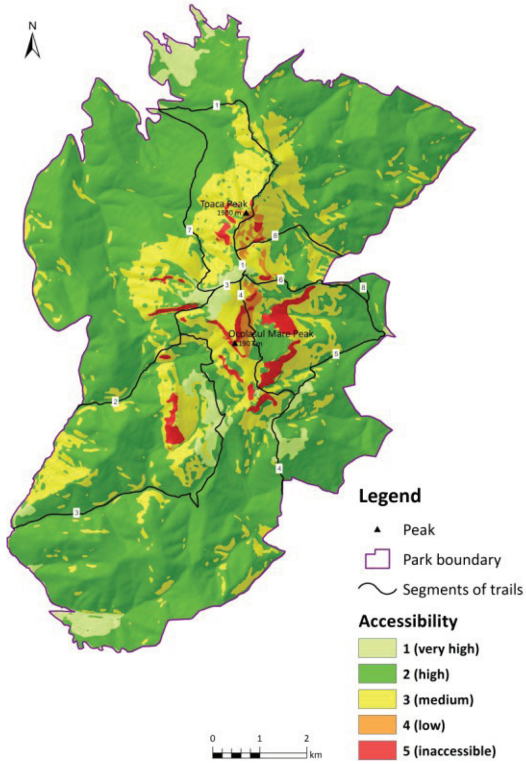


Fig. 5. The map of relief accessibility in CNP

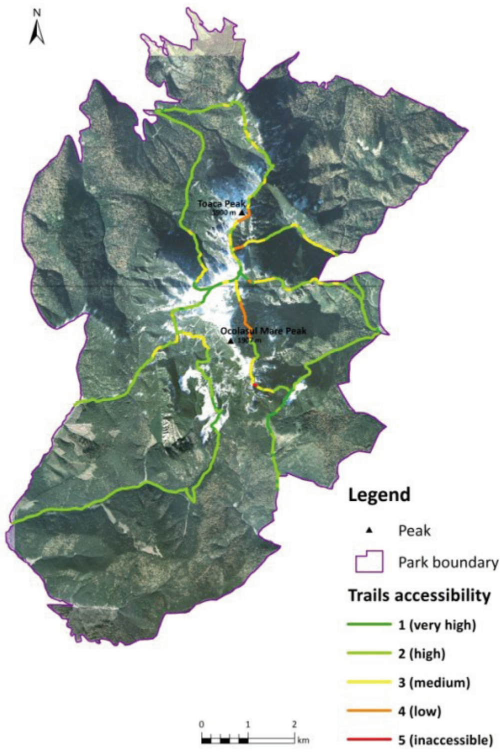
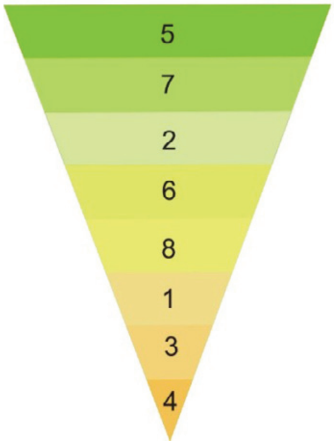


Fig. 6. The accessibility of hiking trails in CNP



1	2	3	4	5
6.95	87.19	5.86		
10.42	73.10	16.48		
	78.71	21.29		
8.60	70.03	20.37	1.00	
	52.40	42.27	5.18	
6.78	57.53	29.76	5.93	
19.15	73.58	7.22		0.05
24.93	31.76	29.52	13.01	0.78

Fig. 7. The classification of hiking trails in CNP according to the accessibility degree (to the right the trail number, to the left the percentages of the different accessibility types)

5. Discussion

Our model can be easily applied for trails in national parks or other mountainous areas that present similar topographic and land use conditions. It can be a useful tool for tourists - who can choose a trail based on accessibility or the period of year when they want to go through - as well as for managers of protected areas. When designing trails it can be predicted the extent to which they would require additional development work such as removal of the vegetal cover and works to combat soil erosion [39]. After applying the algorithm described previously, we produced the relief accessibility map for the entire space in CNP (see Fig. 5) and for the hiking trails (see Fig. 6) that are considered basic facilities in national parks [22].

In our approach we took into account that accessibility can be measured by units [12] which depends on the physical conditions (slopes in our case) and land use. A more complex method - involving the environmental conditions was used [40], but we preferred to limit ourselves at this stage of the study only to the first two elements.

The CNP trails encompass 42.56 km that are complemented by other 26.5 km of paved roads and forestry ones. Compared to the total area (7 742.5 ha) the 8 tourist trail segments (see Fig. 6) don`t put a high pressure on this mountain area.

To reclassify the types of accessibility we took into account the ideas that were already used [14, 15, 16, 41] which consider that there is a close relationship between the type of land use and slopes. Reclassification of land use types was not achieved from a pre-established model [42] but it respected the types that were present in the field because we believed that there are no universal rules that can be applied everywhere when it comes to criteria and their relative importance. Unlike Dong et al. [9] who uses only two categories of accessibility (low and high) - which we have considered limiting - we have chosen the five categories [21] in order to value the complex situation of the terrain.

Knowing the specifics of access for the trail segments is useful in the conditions when there is additional information offered. For example, a tourist map representing the relief accessibility can insert additional images for a better representation (Fig. 8). Another direction of research in this domain may be the development of accessibility maps from which it can be gathered information about the additional facilities or risks placed on the trails, as useful instruments for both visitors and managers [28].

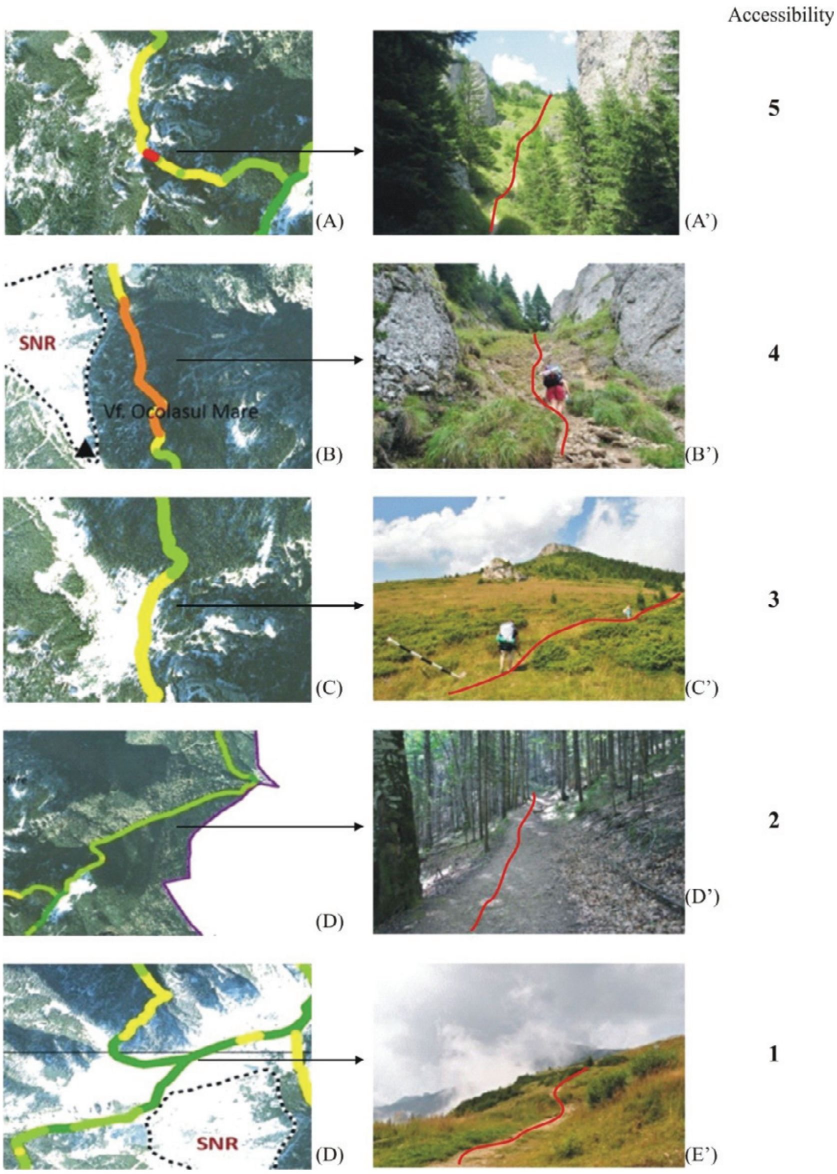


Fig. 8. Examples of accessibility on the hiking trails in CNP: A, A' – very low accessibility (accessibility code 5); B, B' – low accessibility (accessibility code 4); C, C' – medium accessibility (accessibility code 3); D, D' – high accessibility (accessibility code 2); E, E' – very high accessibility (accessibility code 1).

Field validation of the data thus obtained shows that the model is real and applicable. The historical use of the trails, in periods when people had as only means of access to the mountain area the walking or horse riding, explains the fact that they searched the most accessible slopes to reach high altitudes in the center of Ceahlău Massif.

The model proposed by us also has limitations in applicability. Firstly when it comes to accessibility on a tourist trail we cannot correlate this aspect with the visibility that a certain type of vegetation allows it or not. This is a factor taken into account only for forest ecosystems, and not when we made the reclassification for the transition ecotons with greater heights of 2 m. The intersection between declivity, land use and a visibility index would have allowed the delineation of the trail segments and panoramic points that are essential in the ecotourism planning of a national park. Another element that was not considered in our analysis is the internal park zoning. The CNP has two scientific reserves (IUCN category I), but they are not crossed by hiking trails. In other parks, the trails cross nature reserves and therefore this aspect should be considered.

6. Conclusions

This study tested a methodology for achieving the map of relief accessibility relief that is a useful tool for tourists and for managers of protected areas. The model of map that we proposed will help park managers in achieving objectives such as opening new hiking trails or planning some segments for ecotourism activities. The map proposed by us can be used not only in protected areas but also in mountainous areas with similar characteristics in terms of morphology, morphometry or land use.

Acknowledgments

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